

**Within-species variation in *Periclimenes yucatanicus*
(Ives), with taxonomic remarks on *P. pedersoni* Chace
(Crustacea: Decapoda: Caridea: Palaemonidae)**

Mary K. Wicksten

Department of Biology, Texas A&M University, College Station,
Texas 77843, U.S.A.

Abstract.—The spotted cleaner shrimp *Periclimenes yucatanicus* is found to vary in the number of rostral teeth, length/width ratio of the carpus of the major cheliped, color pattern and cnidarian host. Similar variation has been found in other species of *Periclimenes*. Morphological features and type of host have been used to distinguish between *P. anthophilus* Holthuis & Eibl-Eibesfeldt, and *P. pedersoni* Chace, but these features overlap extensively; therefore, *P. anthophilus* is herein considered to be a junior synonym of *P. pedersoni*.

Shrimp of the genus *Periclimenes* Costa, 1844 are among the most colorful carideans of coral reefs. Species inhabiting cnidarian hosts are among the best known. Four species of *Periclimenes* have been reported to live with cnidarians in the western Atlantic, Gulf of Mexico and Caribbean: *P. yucatanicus* (Ives 1891), *P. pedersoni* Chace, 1958 *P. anthophilus* Holthuis & Eibl-Eibesfeldt, 1964 and *P. rathbunae* Schmitt, 1924. (See Chace 1972, for a key to the species of *Periclimenes* in the area).

During studies of cleaning behavior of shrimp and fish, species of *Periclimenes* were observed on coral reefs near Key Largo, Florida, U.S.A., and Bonaire, Netherlands Antilles. The shrimp were identified from photographs and by sight. However, during night dives at Bonaire, shrimp with an unusual color pattern, unlike that of known species in the area, were observed. These shrimp were found in association with the giant sea anemone, *Condylactis gigantea* (Weinland).

To identify this unknown shrimp, specimens were collected and compared with previously identified material. Photographs of live animals were examined to compare color patterns of the unknown shrimp with

those of species of *Periclimenes* known to inhabit sea anemones in the area. Records of shrimp species and their hosts were quantified. The results indicate that there is considerable within-species variation in at least two species of *Periclimenes*.

Methods

During studies of cleaning behavior, this writer and volunteer divers from the non-profit organization CEDAM International, counted numbers of shrimp per species of host in Key Largo, Florida, U.S.A., during 11–17 July 1992, and Bonaire, Netherlands Antilles, during 25 July–5 August 1993 and 30 July–12 August 1994. Shrimp were observed during SCUBA dives at depths of 3–22 m between 0600–2200 hours. Twenty-four photographs of all species of *Periclimenes* were taken in Florida and 110 in Bonaire. Species were identified in the field according to the color patterns shown in the popular book by Humann (1992:151); unidentified ones were reported as *Periclimenes* sp.

Five specimens (the maximum number allowed as stated on the collecting permit) of the unidentified shrimp were collected at

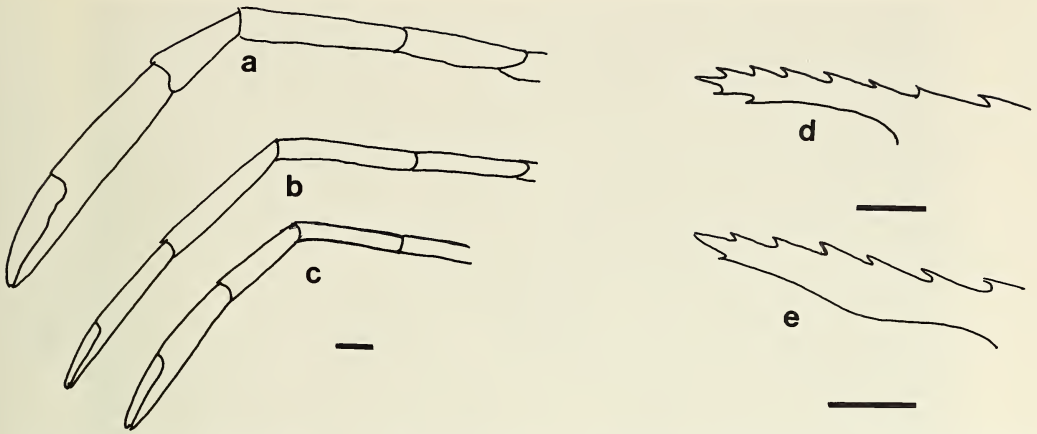


Fig. 1. Variation in the rostrum and second pereopod of *Periclimenes yucatanicus*. a, left second pereopod from individual 29.8 mm in total length; b, c, left and right second pereopods from individual 16.5 mm in total length; d, rostrum from individual 29.8 mm in total length; e, rostrum from individual 13.0 mm in total length. Scales are 1 mm and refer to the drawings immediately above them.

Calabas Reef, near Kralendijk, Bonaire, during 1994. An additional 13 were photographed in their natural habitat, but not collected. The animals were kept alive for 5–7 days and their color patterns recorded. These specimens were compared with descriptions of known species and also with 13 specimens of *P. yucatanicus* from the collections of the National Museum of Natural History Smithsonian Institution, Washington, D.C. The color patterns also were compared with those shown in photographs of *P. yucatanicus* from Grand Cayman, British West Indies (two slides showing three shrimp), Isla Cozumel, Quintana Roo, Mexico (three slides showing two shrimp), the U.S. Virgin Islands (one photograph of one shrimp) and Discovery Bay, Jamaica (photograph by Colin 1978).

Results

The unidentified shrimp are a previously unreported color variety (hereafter called the nocturnal color phase) of *P. yucatanicus*. Their bodies closely match the description of *P. yucatanicus* as given by Holthuis (1951: 38, pl. 10, figs. a–l). In these specimens and

previously collected material of the species, there is variation in the number of rostral teeth and the length-width ratio of the carpus of the second (major) cheliped (Fig. 1). The rostrum can have 5–8 dorsal and 0–3 ventral teeth in addition to an acute apex. The length/width ratio of the carpus ranges from 2.3–7.5. A more slender carpus (4× longer than wide or more) usually occurs in smaller shrimp (total length 16 mm or less). (The largest specimen measured 29.8 mm in total length, orbit-telson.) In three specimens, the second pereopods were asymmetrical.

The 18 shrimp of the nocturnal color phase had translucent bodies with a few small spots of brown or white on the dorsal surface, and a translucent turquoise blotch near the gastric region. In two, there was a pale white stripe along the dorsal midline; in another two, there was a small dorsal pale brown spot on either the carapace or third abdominal somite. The pereopods were banded. Most had white antennae, but two had the outer antennal flagella banded and the inner ones white. In two, the uropods ended in faint white spots; in the others, there either were no such spots or the tail



Fig. 2. Color variation in *Periclimenes yucatanicus*, drawn from photographs in life. a, entire animal, showing banded appendages, from Florida, day; b, individual from Bonaire, day; c, individual from Bonaire, night; d, individual from Bonaire, day; e, same individual as seen in drawing d, night; f, individual from Bonaire, day.

fan could not be observed in the photograph.

Two of the individuals that were collected at night are shown in the nocturnal color phase in Figs. 2c and 2e. By day, both changed their color pattern to that of large white, tan, green or purple blotches, spots and saddle marks on a translucent body. The same individual is shown in Figs. 2d and 2e, illustrating the marked change in color pattern. Examination of the live specimens and photographs revealed considerable color variation in *P. yucatanicus*. Some of the patterns are shown in Figure 2. Of

the 82 photographs identifiable as *P. yucatanicus* taken at Bonaire, all showed shrimp with the pereopods banded with white and a contrasting darker shade of red, purple or violet. Thirty-two shrimp (39%) had entirely white antennae; 34 shrimp (41%) had the outer flagella banded and the inner white, and 16 shrimp (20%) had both antennal flagella banded. Eleven photographs showed only the front of the animal, and thus only the color of the appendages and antennae could be seen. In the other 71 photographs, at least the carapace and first three abdominal segments were visible. The



Fig. 3. *Periclimenes pedersoni* at Bonaire.

color pattern typically included a large dorsal "saddle" of pure white or pink, tan or green with a white border on the dorsal surface of the carapace, (seen in 31 shrimp, or 44% of the total), a saddle (sometimes in a figure-eight pattern) of similar color on the dorsal surface of the first and/or second abdominal somite (seen in 30 shrimp, or 42% of the total), and a large saddle on the third abdominal somite (seen in 46 shrimp, or 65% of the total). The tips of the uropods often were marked with white and dark spots shaped like eyespots; however, the tail fan was visible in only 21 photographs. The lower surface of the carapace or abdomen often had spots of white or white and dark pigment and the anterior parts of the cephalothorax could be speckled; however, it was difficult to see these marks in many photographs. Many shrimp also had "saddle" marks on the fourth abdominal somite, or had marks that overlapped two abdominal somites. Two of the largest shrimp (total body length approximately 30 mm, as estimated from photographs) had a body background color of brownish pigment; most

of the shrimp were translucent except for the bands and spots. Similar color patterns were observed in photographs of shrimp from other areas except for one photograph from Grand Cayman, which showed two shrimp with the same color pattern as the nocturnal color phase from Bonaire. The photograph of *P. yucatanicus* by Humann (1992) shows a shrimp with a brown background pigmentation.

Another common shrimp, *Periclimenes pedersoni*, had very different markings which were not observed to change at night. This species was marked with white, blue or purple-violet lines running the length of the body, similar marks on the major chelipeds, purple speckles on the maxillipeds and other pereopods, and pure white antennae. The white lines and antennae are readily visible at a distance (Fig. 3).

Of 302 total *P. yucatanicus* observed in the wild (whether photographed or not), 283 were among the tentacles of *Condylactis gigantea*, 13 were on the sea anemone *Bartholomea annulata* (Lesueur) and six were away from a cnidarian host. Usually, only

one shrimp was observed per host, but as many as five could be found per anemone. All of the unidentified shrimp at night were found on *C. gigantea*. *Periclimenes peder-soni* was more abundant. Of a total of 938 observed, 555 were on *C. gigantea*, 315 on *B. annulata* and 68 on other hosts or away from a cnidarian. As many as 13 *P. peder-soni* could be found living in a single sea anemone. The two species never coexisted on the same host. The hippolytid shrimp *Thor amboinensis* (De Man) often occupied the same individual of *C. gigantea* with one of the two species; snapping shrimp (*Alpheus? armatus* Rathbun) lived along the stalks of *B. annulata* under the tentacles where the *Periclimenes* lived.

No individuals of *P. rathbunae* were observed at either Key Largo or Bonaire.

Discussion

Holthuis (1951) noted variation in the length/width ratio of the carpus of the second pereopod in specimens of *P. yucatanicus*, and speculated on whether this might be due to sexual difference, a growth form or geographic variation. This asymmetry also could be due to loss and regeneration of an appendage. The results given here suggest that variation in the proportions of the carpus of the second pereopod exists within *P. yucatanicus*. Holthuis noted similar variation in *P. infraspinis* (Rathbun). Chace & Bruce (1993) noted that several Indo-Pacific species of *Periclimenes* had subequal to grossly unequal second pereopods.

The pattern of spots and lines in specimens from Bonaire and Florida was consistent with that shown in photographs of *P. yucatanicus* from other areas. Less variation was seen in the color pattern of *P. peder-soni* (Humann 1992:151; Sefton & Webster 1986:77, figs. 117, 118; Colin 1978: 339–341; Voss 1980:87 and color plate). *Periclimenes rathbunae* has a pattern of white and brown dots and lines, with white dots at the tips of the uropods (Spotte et al.

1991:fig. 1; Colin 1978:344 as “unidentified species of *Periclimenes*”). It is possible that slight regional differences in color pattern may exist in these species, but such differences would be difficult to see or photograph in the natural habitat.

Marked changes in color patterns from day to night have been reported previously in the hippolytid shrimp *Hippolyte varians* *Heptacarpus pictus* and *Heptacarpus palu-dicola* (Green 1961, Bauer 1981). In these species, the shrimp showed a translucent blue color by night, regardless of the color pattern displayed by day. Divers at Key Largo noticed a similar color change in *Thor amboinensis*, which had a pattern of white spots against a chocolate brown background by day, and a blue background at night. There are few observations of the nocturnal coloration of shrimp, especially in their natural habitat, so it is difficult to determine how common diurnal/nocturnal color changes are among species of *Periclimenes*.

Spotte et al. (1991) reviewed associations of shrimp with cnidarians in the West Indies and Bermuda, and reported that neither *P. yucatanicus* nor *P. peder-soni* was confined to a single host. *Periclimenes yucatanicus* was listed to live with six species of sea anemones (Order Actiniaria), the jellyfish *Cassiopeia xamachana* (Bigelow) and the corallimorpharian, *Rhodactis sanctaetho-masae* (Duchassaing & Michelotti). *Pericli-menes peder-soni* was reported to live with six species of sea anemones, the same jellyfish and a tube anemone, *Cerianthus* sp.. At Key Largo, diver Rick Sammon photographed *Periclimenes yucatanicus* in association with another corallimorpharian, *Ri-cordea florida* (Duchassaing & Michelotti). I photographed the same association at Grand Cayman.

Evidently, *P. yucatanicus* and *P. peder-soni* can live on multiple hosts. However, most records of either species come from the anemones *C. gigantea* and *B. annulata*. Goy (1990) found that more larval *P. yu-catanicus* completed metamorphosis suc-

cessfully if exposed to exudates of *C. gigantea* than to those of other species or none at all; larval *P. pedersoni* showed better survival if exposed to exudates of *B. annulata*. Levine & Blanchard (1980) reported that species of *Periclimenes* could be stung by sea anemones to which they were not acclimated.

Periclimenes anthophilus Holthuis & Eibl-Eibesfeldt (1964) was described as a distinct species from Bermuda. The original authors, and Chace (1972) remarked that it was very similar to *P. pedersoni*, but could be distinguished by the position of the hepatic spine in front of the most posterior dorsal carapace spine; the carpus of the second pereopod being less than half the length of the chela and the host being *Actinia bermudensis* or *C. gigantea*. Other morphological features and the color pattern were indistinguishable from those of *P. pedersoni*.

Chace (1972) remarked on the close morphological similarity between the two supposed species, and re-examined specimens. The only differences he found between them were the "different habits" and the "proportionately shorter carpus of the major second pereopod". However, proportions of the carpus of the second pereopod vary in species of *Periclimenes* as well as in other palaemonids. In species of freshwater shrimp of the genus *Macrobrachium*, for example, the entire second pereopod is markedly longer and more robust in adult males than in juveniles or females. As shown in Fig. 1, the length/width ratio of the carpus can vary in specimens of *Periclimenes* spp., as does the length of the carpus relative to the chela.

Although species of *Periclimenes* apparently have preferred hosts, they are not restricted to a single species of cnidarian. The review by Spotte et al. (1991) shows this lack of specificity, as does a study of shrimp living with sea anemones in central Japan (Suzuki & Hayashi 1977). Both *P. pedersoni* and *P. anthophilus* have been reported to live with *C. gigantea* and *B. annulata*, as

well as with other hosts (Spotte et al. 1991). Lacking additional evidence of distinctive coloration or species-specific behavioral or morphological distinguishing features, *P. anthophilus* should be considered a junior synonym of *P. pedersoni* Chace, 1958.

Acknowledgments

I am grateful to Kalli de Meyer, Bonaire Marine Park, and the government of the Netherlands Antilles for permission to conduct studies and collect specimens. Volunteer divers from CEDAM International, especially Rick Sammon, Dave Downs and Stella Covre, and Nancy Sefton of the Cayman Islands aided immensely in photographing and documenting shrimp in the natural habitat.

Literature Cited

- Bauer, R. T. 1981. Color patterns of the shrimps *Heptacarpus pictus* and *H. paludicola* (Caridea: Hippolytidae).—*Marine Biology* 64:141–152.
- Chace, F. A., Jr. 1958. A new shrimp of the genus *Periclimenes* from the West Indies.—*Proceedings of the Biological Society of Washington* 71: 125–130.
- . 1972. The shrimps of the Smithsonian-Bredin Caribbean Expeditions with a summary of the West Indian shallow-water species (Crustacea: Decapoda: Natantia).—*Smithsonian Contributions to Zoology* 98:1–179.
- , & A. J. Bruce. 1993. The caridean shrimps (Crustacea: Decapoda) of the *Albatross* Philippine expedition 1907–1910, part 6: superfamily Palaemonoidea.—*Smithsonian Contributions to Zoology* 543:1–152.
- Colin, P. L. 1978. *Marine invertebrates and plants of the living reef*. T.F.H. Publications, Neptune City, New Jersey, 512 pp.
- Costa, O. G. 1844. Su due nuovi Generi di Crostacei Decapodi Macrouri Nota.—*Annali delle Accademia degli Aspiranti Naturalisti, Napoli* 2:285.
- Goy, J. W. 1990. Components of reproductive effort and delay of larval metamorphosis in tropical marine shrimp (Crustacea: Decapoda: Caridea and Stenopodidea). Unpublished Ph.D. dissertation, Texas A&M University, College Station, Texas, 177 pp.
- Green, J. 1961. *A biology of Crustacea*. H.F. & G. Witherby, Ltd., London, 180 pp.
- Holthuis, L. B. 1951. A general revision of the Pa-

- laemonidae (Crustacea Decapoda Natantia) of the Americas. I. The subfamilies Euryrhynchinae and Pontoniinae.—Allan Hancock Foundation Occasional Papers 11:1–332.
- , & I. Eibl-Eibesfeldt. 1964. A new species of the genus *Periclimenes* from Bermuda (Crustacea, Decapoda, Palaemonidae).—*Senckenbergiana Biologica* 45:185–192.
- Humann, P. 1992. Reef creature identification. Vaughan Press, Orlando, Florida, 320 pp.
- Ives, J. E. 1891. Crustacea from the northern coast of Yucatan, the harbor of Vera Cruz, the west coast of Florida and the Bermuda Islands.—*Proceedings of the Academy of Natural Sciences of Philadelphia* (1891):176–207.
- Levine, D. M., & O. J. Blanchard, Jr. 1980. Acclimation of two species of the genus *Periclimenes* to sea anemones.—*Bulletin of Marine Science* 30:460–466.
- Schmitt, W. L. 1924. The macruran, anomuran and stomatopod Crustacea. In *Bijdragen Tot de Kennis der Fauna van Curacao. Resultaten Eener Reis van Dr. J. van der Horst in 1920.*—*Bijdragen Tot de Dierkunde Genootschap Natura Artis Magistra te Amsterdam* 23:61–81.
- Sefton, N., & S. Webster. 1986. A field guide to Caribbean reef invertebrates. Sea Challengers, Monterey, California, 112 pp.
- Spotte, S., R. W. Heard, P. M. Bubucis, R. R. Manstan, & J. A. McLelland. 1991. Pattern and coloration of *Periclimenes rathbunae* from the Turks and Caicos Islands, with comments on host associations in other anemone shrimps of the West Indies and Bermuda.—*Gulf Research Reports* 8:301–311.
- Suzuki, K. & K. Hayashi. 1977. Five caridean shrimps associated with sea anemones in central Japan.—*Publications of the Seto Marine Biological Laboratory* 24:193–208.
- Voss, G. L. 1980. Seashore life of Florida and the Caribbean. Banyan Books, Inc., Miami, Florida, Revised edition, 199 pp.